Overview:
Participants conduct research on a specified topic and, using the knowledge and resources gained through that research, write a short essay on that topic.

The topic for the 2016 TEAMS written competition is Synthetic Neurobiology. Background information on synthetic Neurobiology is attached - teams are expected to incorporate additional research into their essay.

Essays should describe your team’s navigation through a design process while developing a solution to the challenge.

Challenge:
Your team of engineers at the Synthetic Neurobiology Group is tasked with developing new applications (2-3) for the innovative tools of optogenetics. These applications will help guide the Synthetic Neurobiology Group’s future research proposals. Essays should describe:

1) Background and history of Synthetic Neurobiology and specifically, optogenetics.
2) Application(s) the team considered (not just the final recommendation).
3) Identification of constraints, criteria, and specifications used to make final recommendation (2-3 applications).
4) Description of how the recommendation (2-3 applications) might be tested and further researched.
5) Expected outcome of implementing the team’s recommendation.

Procedure:
1. The coach will announce the topic and provide a copy of the competition regulations to team members.
2. Team members will decide on a research, writing, and production schedule to produce the essay.
3. The completed essay must be uploaded to the specified judging portal by the TEAMS coach no later than midnight Eastern Standard Time, Sunday, June 5, 2016. Directions for uploading the essay will be provided.
4. Entries will be reviewed by evaluators.
5. Evaluators will score each essay. The essay points will be added to the problem solving and oral competition scores to determine TEAMS Best in Nation.

Regulations:
1. Essays must be no longer than 1,200 words (not including bibliography).
2. Essays must be typed and double spaced. They may not be handwritten.
3. Acceptable fonts are 12 point Times New Roman or 12 point Arial.
4. Essays should be formatted according to APA guidelines, including bibliography. [https://owl.english.purdue.edu/owl/section/2/10/](https://owl.english.purdue.edu/owl/section/2/10/)
5. Identifying information will be asked for during the submission process and will include: school name, coach name, team identifier, and student names for the submitting team. Identifying information should not appear in the body of the paper.
Synthetic Neurobiology
(Adapted from Synthetic Neurobiology: Optically Engineering the Brain to Augment Its Function)

Our brains and nervous systems mediate everything we perceive, feel, decide, and do—and act as our ultimate interface to the world. An outstanding challenge for humanity is to understand these neuromedia interfaces at a level of abstraction that enables us to engineer their functions: repairing pathology, augmenting cognition, and revealing insights into the human condition.

The human body is made up of trillions of cells. Cells of the nervous system, called nerve cells or neurons, are specialized to carry "messages" through an electrochemical process. The human brain has approximately 100 billion neurons.

![Parts of a Neuron](image)

Synthetic Neurobiology engineers invent and apply tools to analyze and engineer brain circuits in both humans and model systems. Neuroengineering focuses on devising technologies for controlling the processing within specific neural circuit targets in the brain. The ultimate goal of synthetic neurobiology is to help us better understand—and engineer improvements upon—the fundamental functions of the brain and the nature of human existence.

Neural stimulation hardware has traditionally been either electrical or magnetic in nature. The newly developed optogenetic molecular methods enables neurons to be activated or silenced by multiple colors of light. Optical hardware systems are being engineered for targeted stimulating and inactivating neurons precisely, from one to many at a time, with complex spatiotemporal patterns, even in dense tissue in the living brain. The goal is to find ways to cure intractable psychiatric and neurological disorders.
How optogenetics works

A light-sensitive protein from algae

Take the gene for this protein...

...and insert the DNA into specific neurons in the brain

This protein is an ion channel that opens in response to blue light

Neurons communicate by “firing.” This is an electrical signal created by opening & closing ion channels.

So now you can cause neurons to fire just by flashing blue light!

With the right combination of neurons, you can activate an entire brain circuit to control specific behaviors (like movement)

How can engineers help? Your team of engineers at the Synthetic Neurobiology Group is tasked with developing new applications (2-3) for the innovative tools of optogenetics. How may new techniques enabled by optogenetics empower scientists to better study and understand how the human brain functions? What difficult problems in neurobiology can optogenetics help solve? How may optogenetics impact industries such as prosthetics and gene therapy?

Explore More:

Why Neuroscience Needs Hackers –

Fundamentals of Neuroscience Presents: Small Circuits -
https://vimeo.com/101425853